

Microendoscopic Treatment of the Hypopharyngeal Diverticulum With the CO₂ Laser

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Background and Objective: The hypopharyngeal (Zenker's) diverticulum is a herniation of mucosa and submucosa on the posterior wall of the pharynx. The only treatment is surgical.

Study Design/Material and Methods: Between 1976 and 1993, 109 patients with a hypopharyngeal diverticulum were operated on at the Department of Otorhinolaryngology, Head and Neck Surgery, University of Kiel, either transcutaneously combined with a cricopharyngeal myotomy (n = 76), or microendoscopically (n = 37) using the CO₂ laser. Results and complications of both techniques were evaluated and compared.

Results: With both surgical procedures, >90% of the patients were treated successfully. The rate of postoperative complications was generally low. In comparison to the microendoscopic procedure, serious complications were found to be more frequent in patients treated with the conventional transcutaneous diverticulectomy.

Conclusion: The laser surgical tissue bridge dissection is a less invasive, quick, relatively safe, and effective procedure requiring only short hospitalisation. Therefore, the laser surgical tissue bridge dissection can be considered as the method of choice for the treatment of the hypopharyngeal diverticulum. *Lasers Surg. Med.* 20:394–401, 1997. © 1997 Wiley-Liss, Inc.

Key words: CO₂ laser; microendoscopic surgery; Zenker's diverticulum; diverticulectomy

INTRODUCTION

A diverticulum of the posterior pharyngeal wall was first described by Ludlow [1] in 1769. In 1877, Zenker [2] classified the diverticula of the esophagus. He differentiated between pulsion and traction diverticula and described the hypopharyngeal diverticulum that is named after him as a pulsion diverticulum directly located at the mouth of the esophagus. Usually the main symptom of the hypopharyngeal diverticulum is dysphagia. Other symptoms are regurgitation of undigested food, bad breath, recurrent cough, and in extreme cases lung abscesses or aspiration pneumonia.

For a long time the therapy of choice was the transcutaneous diverticulectomy with an addi-

tional myotomy of the pars fundiformis of the cricopharyngeal muscle [3]. In 1917, Mosher [4] was the first to report an endoscopic treatment of Zenker's diverticulum. In the 1930s, Seiffert [5] and Dohlman [6] independently used this method again, and during the following years it was modified and successfully optimized [7,8]. In 1981, van Overbeek [9] introduced microendoscopic surgery for hypopharyngeal diverticulum using the operating microscope and the CO₂ laser.

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Accepted for publication 1 August 1996.

MATERIALS AND METHODS

Between 1976 and 1993 at the Department of Otorhinolaryngology, Head and Neck Surgery, University of Kiel, 113 surgeries were carried out on 109 patients with a hypopharyngeal diverticulum. The mean age was 68.8 years [range 36–91 years]. Fifty-four patients were male and 55 were female. Seventy-six patients were treated with a transcervical diverticulectomy and simultaneous myotomy of the basal fibers of the cricopharyngeal muscle. Two cases had recurrent disease after previous transcutaneous surgery. Endoscopic laser treatment was performed 37 times on 34 patients. In one case, laser surgery was carried out after a diverticulum recurrence 2 years after conventional external diverticulectomy.

Transoral Tissue Bridge Dissection With the CO₂ Laser

A diagnostic barium swallow (Fig. 3a) of the hypopharynx and esophagus confirmed the presence of the diverticulum prior to surgery. Surgery was performed in all cases under general anesthesia. For optimal display of the tissue bridge, the Groningen diverticuloscope was used until 1988 [9], and afterwards the Weerda diverticuloscope [10]. By spreading the lips of the diverticuloscope, the muscular septum is tightened [Fig. 1]. After optimal display of the tissue bridge, undigested food is suctioned out of the diverticulum. The microscope with micromanipulator and CO₂ laser are set on a working distance of 400 mm and focused on the tissue bridge.

To prevent accidental damage of the esophageal mucosa, cotton wool is used to cover it [Fig. 2a]. Then, the laser surgical dissection starts with an incision in the center of the tissue bridge (1–2 Watt, cw-mode, spot-diameter 0.25 mm). The muscle fibers diverge to both sides and leave a wedge-shape wound that allows an increasing insight into the esophagus [Fig. 2b]. The tissue bridge is dissected down to the fundus of the diverticulum. During this procedure, the mediastinum is always opened [Fig. 2c].

At the end of the operation, a wide passage to the esophagus exists and a nasogastric tube is placed into the esophagus. For 4 days, the patients are treated with metronidazol and cefuroxime. On the first postoperative day, the alimentation only consists of fluids. If the healing is uncomplicated and undisturbed, the nasogastric tube is removed on the second postoperative day.

Prior to discharge from the hospital, a control X-ray is done [Fig. 3b].

RESULTS

Of 34 patients treated with laser surgery, 30 were free of symptoms after surgery. In three cases a significant improvement of the symptoms was observed after transoral tissue bridge dissection. On three patients laser surgery had to be repeated because of an unsatisfying outcome after the first surgery (Table 1). The complication rate after transoral tissue bridge dissection was low. Twenty-eight patients developed high temperatures up to 40°C on the first postoperative day but showed a normal body temperature after another 24–48 hours without any specific treatment. In one case we observed symptoms of a mediastinitis, but the collar mediastinotomy that was carried out did not disclose any pathological substrate. (see Table 3).

Seventy-three patients were free of symptoms after transcutaneous operation. Just one female patient complained about dysphagia and regurgitation 2 years after the operation. After transoral lasersurgery with the CO₂ laser, this patient is now without any symptoms (Table 2). In eight patients, a recurrent nerve paralysis after external diverticulectomy was observed, and three times a mediastinotomy was carried out because of a purulent mediastinitis. A stenosis was noticed in two patients, and one patient had delayed wound healing (Table 4).

DISCUSSION

The hypopharyngeal diverticulum is a herniation of mucosa and submucosa on the posterior wall of the pharynx. A muscular gap, the so-called Killian triangle, is a weak part in the hypopharyngeal wall, limited by the pars obliqua and the pars fundiformis of the cricopharyngeal muscle [11]. The etiology of Zenker's diverticulum is still unclear. The most likely cause lies in the individual anatomical variations of this hypopharyngoesophageal segment. Undoubtedly age and size of Killian's triangle have an important influence on the development of the hypopharyngeal diverticulum. The weakness of Killian's triangle is aggravated by decreasing tissue elasticity and a lower muscle tone in the elderly patient [12]. Additionally, van Overbeek [13] observed in his patient contingent a certain familial incidence.

The adequate treatment of Zenker's divertic-

ulum is surgical. According to patho-anatomical conditions myotomy of the cricopharyngeal muscle is generally thought to be the most important part of surgery no matter what surgical approach is chosen [14,15]. The narrowest part of the pharyngoesophageal segment is widened and the intraluminal pressure of the hypopharynx is lowered during swallowing [12,13].

In addition to the myotomy, the diverticulum sac is resected during transcutaneous operation. In transoral laser surgery, this can be neglected. The transmucosal myotomy allows an easy deglutition of the food bolus from the diverticulum into the esophagus.

The first endoscopic tissue bridge dissection was carried out by Mosher [4] in 1917, but he stopped the treatment after the seventh patient died of a mediastinitis. In the 1920s and 1930s, Seiffert [5] and Dohlman [6] independently started using the endoscopic approach again. Whereas Seiffert dissected the tissue bridge with a specially developed pair of scissors, Dohlman coagulated the tissue bridge first with insulated forceps and then used a diathermy knife to transect the muscular septum. In the following decades, this method was significantly improved by modification of the instruments [7,9]. Especially the development of improved diverticulosopes for endoscopic surgery made the operative procedure easier to perform [7,9,10,16]. With the Weerda diverticuloscope [10] that allows an adjustment to the individual anatomical conditions, optimal presentation and visualization of the tissue bridge are possible. In 1981, van Overbeek [9] used the CO₂ laser for the first time to dissect the tissue bridge under microscopic control. Because of good functional results and a low complication rate, this technique was employed by many other clinicians [17–20]. Another modification of the endoscopic technique was the development of a stapler for tissue bridge dissections [21,22]. The number of patients treated with this technique is too low to allow any statements concerning the effectiveness of this modification.

The extent of the tissue bridge dissection is an important difference between the various reported procedures. Seiffert [5], Vogel [23], and Legler [24] dissected the tissue bridge down to the fundus of the diverticulum. During this procedure the mediastinum is opened. In contrast, other authors consider that a complete dissection is not necessary, especially when large diverticula are operated [10]. To avoid an opened mediastinum and the potential complications, we did not dis-

sect completely the tissue bridge when we started the lasersurgical dissection at the Department of Otorhinolaryngology, Head and Neck Surgery (University of Kiel). The achieved results were functionally unsatisfying, so that we discontinued this method for a short period of time [20]. The change of the technique now with a complete dissection of the muscular septum resulted in very good functional results [25]. A broad wedge-formed wound develops in large hypopharyngeal diverticula. Usually the healing is fast without substantial scarring [26].

Because of potential life-threatening complications, the endoscopic tissue bridge dissection was rejected by various authors [27]. Especially feared is bleeding from atypically located arteries. Seiffert [5] and Herrmann [27] reported a lethal outcome through bleeding of a thyroid artery after previous thyroid gland operation. Legler [24] lost a patient due to bleeding from an A. lusoria. The bulging of the artery into the esophageal lumen was misinterpreted as the tissue bridge of the diverticulum. To exclude an atypically located artery, Weerda [28] recommends angiography prior to any transoral tissue bridge dissection. Heavy intraoperative bleeding is extremely rare and occurs in <0.4% of the endoscopic tissue bridge dissections. By employing the laser surgical technique, the bleeding risk is further minimized. Under microscopic control even pulsations of very small arteries are easy to visualize. By using modern micromanipulators, the tissue can be prepared precisely and step by step, so that severe bleeding can be avoided. Small arteries are coagulated instantly by the CO₂-laser [29], and therefore we do not coagulate the lateral part of the tissue bridge prior to dissection [25].

A second severe complication is mediastinitis. The frequency is between 0.2 and 5.6%, and even deadly outcome is reported [13,30]. During each tissue bridge dissection, the mediastinum is opened. It is generally thought that through inflammatory processes the diverticular wall and the esophagus are glued to each other, and this subsequently prevents the development of a purulent mediastinitis. Additionally a pressure gradient between mediastinum and esophagus leads to a quick closure of the esophagus and the frontal wall of the diverticulum, thus preventing a long opening with subsequent infection [5,25]. As an additional protection we treat the patients for 4 days with antibiotics. In a high percentage after laser surgical dissection, the patients develop fever up to 40°C on the first postoperative day. This

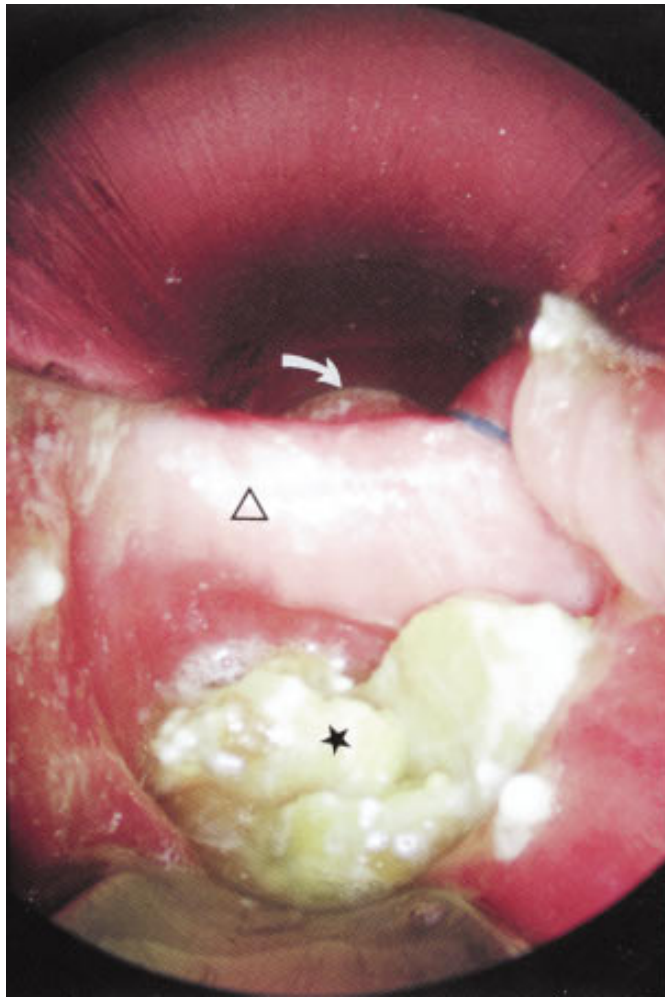


Fig. 1. Endoscopic picture of a 64-year-old male patient with Zenker's diverticulum. The tissue bridge (Δ) is stretched between the lips of the Weerda diverticuloscope. In the back the opening of the diverticulum, that is filled with undigested food (\star); in the front the esophagus (\diamond).

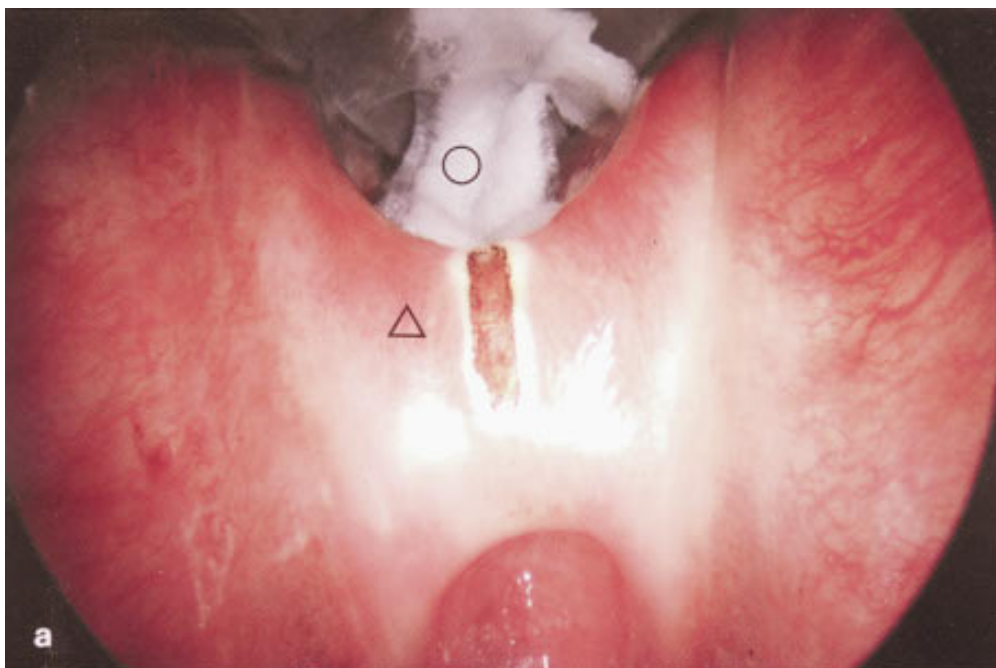


Fig. 2a. (continued on following page.)

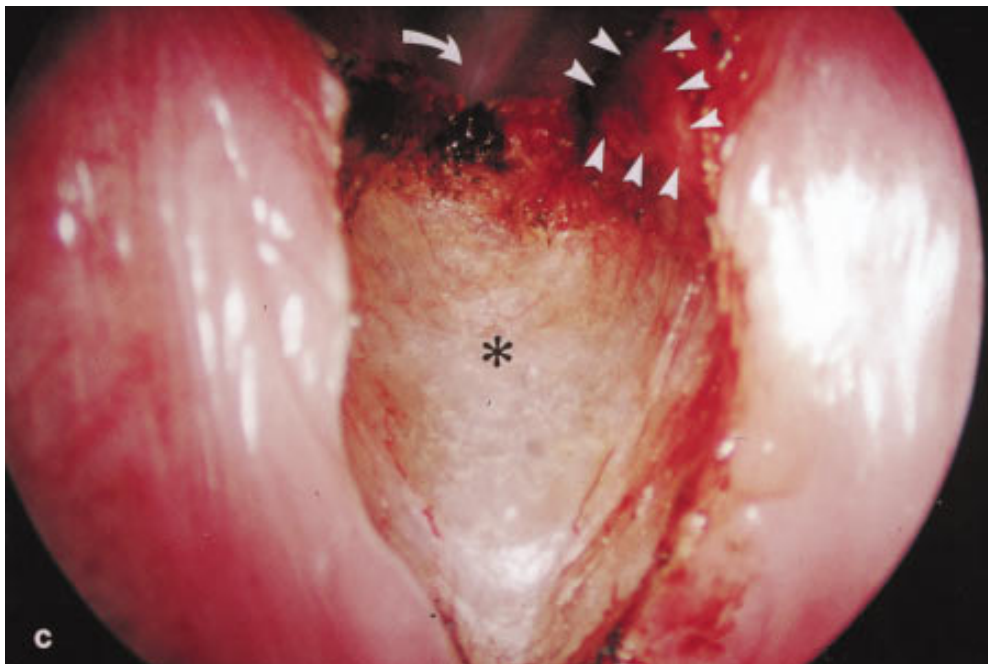
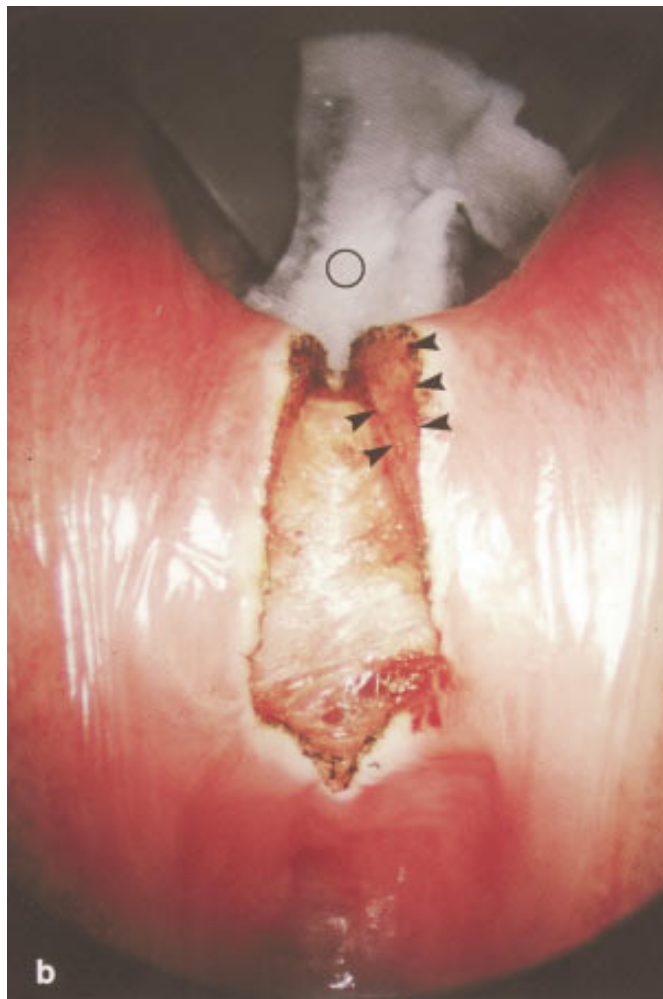


Fig. 2. Tissue bridge of the hypopharyngeal diverticulum of a 89-year old female patient. (a) The tissue (out) bridge is dissected with the CO₂ laser after wet neurosurgical cotton wool (○) is placed in the esophagus. (b) A wedge-shaped wound develops after dissection of the muscle (➤). (c) The tissue

bridge is dissected down to the fundus of the diverticulum. At the end of the operation the muscle is totally dissected (➤) there is a broad access to the esophagus (⇔) and the [redacted] astinum is opened (*).

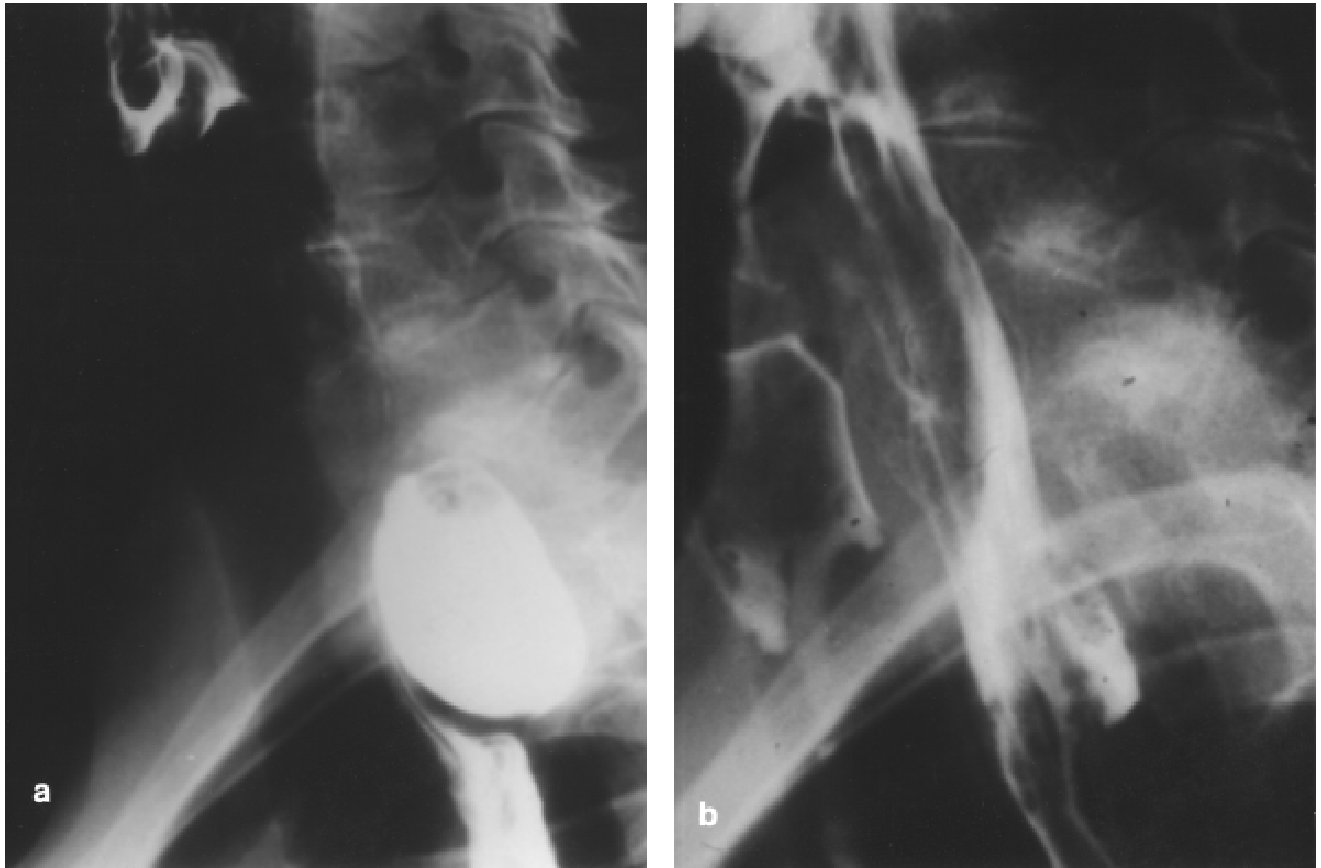


Fig. 3. X-ray examination of hypopharynx and esophagus (a) before and (b) 1 year after endoscopic tissue bridge dissection with the CO₂ laser. There is no diverticulum detectable 1 year after surgery.

TABLE 1. Results After Laser Surgical Tissue Bridge Dissection (37 operations on 34 patients)

Without symptoms	30 ^a
Improved	3
Unsatisfied	1

^aThree patients were without symptoms after a second operation.

TABLE 2. Results After Transcutaneous Diverticulectomy (n = 76)

Without symptoms	73
Improved	2
Unsatisfied	1 ^a

^aAfter laser surgical treatment, the patient was without symptoms.

TABLE 3. Complications After Lasersurgical Tissue Bridge Dissection (n = 37)

Suspected Mediastinitis	1	mediastinotomy without detection of a pathological finding
Fever (1st postopt. day)	28	

TABLE 4. Complications After Transcutaneous Operation (n = 76)

Recurrent nerve paralysis	8	10.4%
Mediastinitis	3	3.9% mediastinotomy with the detection of pus
Wound healing problems	1	1.3%
Stenosis	2	2.6% no therapy necessary
Fever	2	2.6%

phenomenon is not observed after conventional endoscopic tissue bridge dissection or other laser-surgical procedures in the head and neck region [9,18].

If the rate of complications of the transcutaneous procedure is compared with the *transoral* method, no significant difference is detectable. Besides the risk of mediastinitis, in our patients with 3.9 % significantly higher than in the laser-surgically treated patients, recurrent nerve paralysis is observed in 3–6% of the cases, a stenosis in 1–2%, and wound healing problems or the development of a fistula in 0.7–5.6% [7,27,30]. Especially remarkable is the relatively high occurrence of recurrent nerve paralysis with 10.4% in our patient group. In two cases it was an operation after a diverticulum recurrence, and in two other cases the nerve lesion occurred after mediastinotomy in a purulent mediastinitis. Also for the transcutaneous operation, occasional lethal outcomes are reported [30].

The functional results after laser surgical tissue bridge dissection are excellent. Van Overbeek [13,26] reported that just 0.7% of 216 patients were unsatisfied with the treatment. Similar success rates are reported by Benjamin [17], Knecht [18], Kuhn [19], and Flikweert [31]. The partly unsatisfying results in our patient group were caused by incomplete dissection of the tissue bridge, when we introduced this laser surgical operation technique. The functional results after modification of the *transoral* technique were then also very good. According to our observations, the size of the diverticulum is in contrast to Welch's report [32] unimportant for the success of laser surgical therapy [13,17].

The use of operation microscopes, specific diverticulosopes, and the CO₂-laser as cutting instrument are important improvements of the conventional endoscopic tissue bridge dissection performed by Seiffert and Dohlman. The main advantages of the laser surgical dissection are the excellent orientation during surgery, no bleeding, less tissue trauma, less postoperative pain, and oral alimentation after 2–3 days. In contrast to the transcutaneous operation technique, the *transoral* tissue bridge dissection can be carried out repeatedly without an increasing risk [7,13]. Because of the short operating time, patients recover more quickly, thus reducing hospitalisation. Since the functional results are excellent and the complication rate is low, we consider the *transoral* lasersurgical tissue bridge dissection the treatment of choice for Zenker's diverticulum.

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